

Cities and Flooding: Lessons in resilience from case studies of integrated urban flood risk management

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Abstract

Flooding can cause disruption and devastation in cities, with massive damage to livelihoods, property and urban infrastructure as recently experienced in New York City, Jakarta, Bangkok, Accra, Mississippi and Queensland. For cities in developing nations, unplanned urban expansion, poor infrastructure and services, inadequate drainage and weak institutional capacity can multiply the negative impact of flooding. In such circumstances, floods often affect informal settlements and bring the additional burden of diverting resources away from poverty alleviation and other development efforts. Preparing for future floods, which may become more frequent in the future, integrated flood risk management recognises that risk reduction which relies solely on engineered defences may be uneconomic, impractical or make flood risk worse under certain circumstances. Therefore authors advocate for a holistic and forward-looking approach to improve resilience of cities in which appropriate engineered measures are combined with non-structural mechanisms, land use planning, emergency preparedness and recovery planning. Decision-makers can use this approach as guidance in implementing balanced and robust solutions in flood risk management.

Funded by the World Bank / Global Facility for Disaster Reduction and Recovery (GFDRR), the flagship report '*Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century*' was designed to provide operational assistance to policy-makers and technical specialists, particularly in the rapidly expanding cities and towns of the developing world, on how best to manage the risk of floods. Comprehensively dealing with available structural and non-structural measures, the handbook provides common guiding principles to building resilience to urban flooding. Over 50 case studies, carefully selected from extensive literature review, workshops and consultations, illustrate current practice, challenges, and lessons learnt from around the world. International and local workshops were held to test and disseminate the key findings and recommendations. A major objective of the research project was to develop a set of policy principles and practical recommendations, based on the case studies, literature and inputs from expert participants at the workshops, to support the implementation of integrated flood risk management through a structured, iterative and participatory process.

Keywords: Resilience, Adaptive Capacity, Urban Flood Management.

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1. Introduction

Flooding poses a serious and frequent risk that challenges the lives of citizens of many major cities around the world (Jha *et al.*, 2011). Direct, rather than indirect, impact from major flood events, as witnessed for example in New York City, Lagos, Pakistan, Mississippi and Australia, are often thought to represent the biggest risk to life and property (Department for International Development, 2005). However, indirect and often long-term effects, such as disease; reduced nutrition; disrupted education; and loss of livelihoods, can have pernicious long-term effects, eroding community resilience and other development goals (UN Habitat, 2010b). In addition to large-scale events, minor and regular flooding can be equally difficult to cope with and detrimental in the long-term. While they are hard to immediately identify and quantify, evidence shows that the poor and disadvantaged suffer the most from long-term effects of flooding (Cannon, 2000, Dodman *et al.*, 2009, World Bank, 2012).

Urban development, rapid growth and increased density of cities are trends implicated in both the increased frequency of flooding and the higher impact associated with urban floods (Jha *et al.*, 2011). The reduced permeability of landscapes associated with urbanisation increases run-off and reduces the capacity of natural floodplains to quickly absorb flows. Higher levels of development expose more people and assets to flood hazard. Rapid urban expansion, which typically takes place without following structured or agreed land use development plans and regulations, makes unsustainable conditions even more problematic. In addition, the urban poor are often excluded from the formal economy, and lack access to adequate basic services. Because of limited resources, and often rights, they tend to be located in densely populated informal settlements (UN Habitat, 2010b).

In response to these challenges, the World Bank handbook for integrated flood risk management was conceived to give guidance in the design and implementation of holistic flood risk management measures that can reduce risk and increase resilience of cities to flood risk challenges in the 21st Century. The handbook incorporated a collection of case studies that informed the development of key principles for integrated flood management. More than 50 examples are used throughout the guide to illustrate particular aspects of integrated flood risk management strategy and systems. While it is impossible to entirely eliminate flooding from cities, the integrated flood risk management approach helps decision-makers and specialists to reduce the vulnerability, manage residual risks, and increase the resilience of the built environment to flood hazard. This paper focuses on the link between integrated flood risk management and improving resilience in cities. The following sections describe the concept of flood resilience within four “capacities”.

2. Concepts of resilience and capacity

Resilience is a contested concept that has gained prominence in the disaster management community over the last decade (Tierney and Bruneau, 2007). The multidisciplinary nature of the disaster management profession ensures that the definitions and concepts of disciplines as wide apart as engineering, finance, ecology and psychology have contributed to the debate around what truly constitutes a resilient environment (Folke *et al.*, 2002, Gallopin, 2006, Institution of Civil Engineers, 2008, Defra/Environment Agency, 2011).

Narrow definitions of resilience, owing their heritage to engineering and from the Latin “resilio”, which means to “jump back”, usually encompass the ability to return back into shape after being affected by external shock (Plodinec, 2009). The shock absorber or “sponge” concept that is the direct opposite of vulnerability (IPCC, 2001) is the root of the definition of building resilience (wet-proofing) where the acceptance of water into a property is mitigated by the use of techniques and materials that will suffer little damage from contact with flood water or are easily removed, cleaned or replaced (Wingfield *et al.*, 2005). Within this definition of resilience, the construction of flood resistant housing can also be considered a resilience measure, as it reduces damage and allows the city to recover more quickly.

In the context of disaster risk management, the definition of resilience increasingly focuses on community resilience and is shifting towards terminology borrowed from ecology and social sciences. Adger (2000) for example defines social resilience specifically as relating to a community’s ability to withstand external social, economic, and political shocks. Bruneau *et al* (2003) offer the definition that resilience is “the ability of social units (e.g., organizations, communities) to mitigate hazards, contain the effects of disasters when they occur, and carry out recovery activities in ways that minimize social disruption and mitigate the effects of future disasters.” Whilst Zhou *et al* (2010) more narrowly refers to “the capacity of hazard-affected bodies (HABs) to resist loss during disaster and to regenerate and reorganize after disaster in a specific area in a given period”. Conversely, Pelling (2003), has a broader definition that “Resiliency is thought of as a characteristic of systems that offers flexibility and scope for adaptation whilst maintaining certain core functions (for example, access to basic needs and social stability)”. The definition holds, at its core, the notion that the state of normality post disaster need not be recognisably similar to the pre disaster normality and emphasises the role of adaptation in the complex evolving system of a modern city. Adger *et al* (2004) posit that a key concept of the resilience of systems is the potential for self-organisation or spontaneous response as opposed to responses imposed by external forces. This implies risk reduction approaches that are people centred and react to local knowledge, and therefore research on resilience needs to understand how communities and individuals survive and cope with disasters.

Increased resilience is also linked to vulnerability reduction although the relationship between vulnerability and resilience is not easy to specify (Adger, 2006). Using the broader definitions of resilience implies that many measures that reduce vulnerability can also be said to increase resilience and this may be reflected in the strengthening of four capacities within the built environment namely: *threshold, coping, recovery and adaptive capacity*. In the context of managing flood risk, *threshold capacity* is the level to which flood hazard must reach before damage and disruption is widespread. *Coping capacity* reflects the ability of cities to continue to function despite the threshold capacity being exceeded. *Recovery capacity* is related to the speed and effectiveness of the return to normal operations of the city after a flood; while *adaptive capacity* denotes an ability to use the recovery period and the time between events to enhance the other three capacities (De Graaf, 2008). Adaptive capacity is central to the broad concept of resilience adopted in this paper. However, while increased resilience results from decreased vulnerability of people and assets it may also result from a general adaptability or coping ability and underlying socio-economic and political factors quite divorced from the flood hazard.

The focus on resilience in flood management shifts the balance of risk reduction within cities from measures perpetrated by authorities to a more collective approach (The World Bank and the United Nations, 2010). As a consequence a coherent, locally-specific and integrated response is needed. The increased resilience of cities therefore requires structural changes to reduce the expected damage from flooding to be balanced with non-structural adaptations directly related to flood management and urban management mechanisms that strengthen the underlying ability of the population and built environment to accept and adapt to change.

Particularly in rapidly developing countries, urban authorities need to address the issues of infrastructure and urban expansion if they want to increase resilience. The broadening of flood risk reduction measures might also affect the clarity in the ownership and perceived responsibility to manage flood risk (De Graaf, 2008), which is why clear institutional arrangements and coordination among the key actors is vital. Flood management can hugely benefit from the involvement of all stakeholders to increase the collective resilience of a city.

3. Strengthening the capacity for resilience: case study examples

As indicated in the section above, resilience of cities can be enhanced by measures that reduced the vulnerability of individuals and communities to flood risk. Selected case studies, included in the World Bank handbook, illustrate how one or more of the four capacities can be strengthened. The case studies were carefully chosen based on a systematic review of relevant literature and examples suggested in consultations and workshops. The selected collection, reaching across Africa (e.g. Ghana, Mali, Mozambique, Senegal, Somalia, Togo, Tunisia, Zambia), East Asia and the Pacific (e.g. Australia, Cambodia, China, Japan, Malaysia, the Mekong region, Micronesia, the Philippines, Samoa, South Korea, Thailand, Vietnam), Southeast Asia (e.g. Afghanistan, Bangladesh, India, Nepal, Pakistan), South America (e.g. Argentina, Brazil, Colombia, Mexico), North America (Canada, the U.S.) and Europe (e.g. France, Germany, Poland, the UK), represents different flood types, geographies, socio-economic variables, city sizes and flood risk measures. A quantitative evaluation of such a diverse body of examples would be limited as the flood circumstances and outcomes were complex and varied, hence a qualitative method was applied.

3.1 Threshold Capacity

Threshold capacity can be increased by many structural alterations to the fabric of a city (Barker, 2011). Some of these measures are the traditional structural changes to the buildings and infrastructure such as raising of buildings (Lamond and Proverbs, 2009) and engineered protection of critical infrastructure (Fankhauser *et al.*, 1999, Kidd, 2011). Increasingly, careful land use planning and regulation, are recognized to be able to reduce the flows associated with a given weather event, while at the same time direct populations out of hazardous areas (APFM, 2007). Furthermore, the implementation of effective and sustainable urban drainage can be employed to absorb flows avoiding damages and losses (Charlesworth and Warwick, 2011).

The following example illustrates plans in New York City to improve the use of urban drainage to control stormwater runoff while decreasing the impact of severe weather by

raising the storm threshold. The New York City Green Infrastructure Program, which forms part of the Green Infrastructure Plan of the Department of Environmental Protection (DEP), introduced new regulations and guidance on the design of stormwater management for new development (NYC Environmental Protection, 2012). The program creates incentives for green infrastructure projects including green-roofing and creating porous paving by property owners, businesses, and community organizations eligible for the funding. The aim was to improve the water quality of the city's waterways while reducing sewer overflows and flooding. Several demonstration projects have been constructed to show the benefits in practice including blue and green roofs at schools and rain gardens in public open spaces (NYC Environmental Protection, 2011). Initial assessments indicate that green infrastructure has the potential to be cost-effective as there are multiple benefits for the infrastructure over and above the reduction in flood risk. The success of the initiative will depend on the sustained support from local communities and businesses. To ensure this, the City has formed a Citizen's Group and steering committee from professional stakeholders and other integral communities. The latest update indicates that approximately US\$3.8 million has been awarded to local organizations and private property owners engaged in these resilience activities (NYC Environmental Protection, 2011).

3.2 Coping Capacity

Coping with flood events includes structural and non-structural measures such as: early warning and evacuation (Evans, 2011); emergency planning (Emergency Management Australia, 2000); business continuity plans, and temporary flood barriers and shelters (Jha *et al.*, 2012). Valuable lessons in resilience can be drawn from grassroots experiences of dealing with hazards. Understanding local responses can contribute to the strengthening of planning strategies for adaptation to climate change and variability in cities, and avoid situations when imposed solutions do not fit local conditions and customs.

For example, Dhaka, the capital of Bangladesh with over 10 million inhabitants, is central to Bangladesh's economy. Having experienced nine major floods in the last 55 years and frequent smaller events (Jabeen *et al.*, 2010), the country and city are highly susceptible to flooding. Large areas of the city are only a few metres above the sea level (Dodman *et al.*, 2009). Karail, the largest informal settlement of roughly 100,000 inhabitants, has large areas in the lowest-lying regions and hit by regular inundation. A vulnerability survey carried out by the Development Planning Unit at University College London (UCL) in co-operation with BRAC University in Bangladesh, examined household and collective adaptation strategies to cope with existing environmental hazards (Jabeen *et al.*, 2010). Research indicates that that local coping strategies, that have been adopted either at the household or community level to reduce vulnerability, include physical modifications to the buildings, savings and access to credit, diversified income sources, strong social networks and accumulation of assets. Findings show that the circumstances of living in informal settlements led to the tendency for families to resist evacuation during and after flooding for fear of permanent displacement. Authorities should therefore consider a mix of measures that support the existing local strategy of rebuilding from savings and accumulated assets through risk transfer and micro-finance mechanisms while considering long-term poverty reduction, secure resettlement, and security of tenure to address both flood risk and wider development goals.

3.3 Recovery Capacity

The ability to recover is embedded in all understandings of resilience and encompasses physical, mental and socio-economic aspects. The capacity to reinstate the built environment quickly after flooding minimises the distress and disruption caused by flood events (Samwinga *et al.*, 2004, Active Learning Network for Accountability and Performance in Humanitarian Action (ALNAP), 2008). Rapid damage and loss assessment and effective damage repair arrangements can be highly effective in enhancing community resilience. Similarly, recovery plans, prepared in advance of flooding, increase the likelihood of a swift return to normality, and even lead to an improved and more resilient city (Jha, 2010).

Central to recovery planning is the provision of necessary resources and the ability to direct them effectively to the ones in need while working towards enhancing the future resilience of cities through implementation of resilient building techniques. Financial resources can be provided through many sources including donations, disaster risk financing and insurance products, such as catastrophe funds or public funds, as well as through existing community-driven development program, or social protection and livelihoods support programs, such as cash-for-work transfers. The balance between private financing and communal or charitable disaster pools requires an assessment of the local capacity, risk and designation regimes as well as broader socio-economic and cultural considerations. Nation-wide schemes should fit the needs of local populations and include multi-stakeholder perspectives.

The case of the 2011 floods in Queensland, Australia, illustrates a number of recovery challenges related to post disaster financing and insurance arrangements. In the three consecutive years beginning with 2009, serious flooding and cyclones affected large parts of the state of Queensland, located in the north-east of Australia. The estimated total cost of the recent floods and cyclones during these three years is US\$ 10.46 billion (Bloomberg, 2012). However, one month after the severe floods of 2011, only 10 percent of the total of US\$2.1 billion worth of private claims had been paid. In January 2011 the Government of Australia ordered a review into all aspects of the response and the aftermath of the 2010 and 2011 flood events (Queensland Flood Commission of Enquiry, 2011, Insurance Australia Group, 2011). The main insurance aspects to be reviewed were: the performance of private insurers in meeting claims for floods and other natural disasters; the potential effect of national government intervention in disaster insurance such as subsidised insurance premiums for individuals and small businesses in high-risk areas; and the need for a national disaster fund to support other financing pools. The Commission collected evidence from individuals and communities that experienced difficulties and delays in recovery due to the denial of their insurance claims and consulted widely after the interim report was issued. The Queensland Floods Commission held a second round of hearings in September and October 2011, and the final 658 page report was published March 2012 (Queensland Flood Commission of Enquiry, 2012). The report proposes changes to the insurers code of conduct in relation to dealing with disputed claims but deferred more fundamental changes until the results of consultations on the wider enquiry into hazard finance by the National Disaster Insurance Review Panel (National Disaster Insurance Review Panel, 2011). The report recognised the importance of the private insurance mechanism to empower communities to help themselves and promoted the provision of improved hazard information and advice on

protection and mitigation for improved resilience (Insurance Council of Australia, 2012). This information is now beginning to be more widely available.

3.4 Adaptive Capacity

The ability of cities to adapt to changes, coping with present hazards without compromising future options is increasingly important in the light of uncertain futures. The drive to enhance adaptive capacity tends to promote flood risk management measures which are incremental in application, reversible and present so called low-regret solutions that bring benefits under a range of future scenarios (Hallegatte, 2009). Adaptive capacity includes dimensions which are generic in nature, focusing on improvements in education, income-levels and health. There are also dimensions specific to a particular hazard such as flooding (IPCC, 2007) or which address a subset of adaptive challenges.

Actions to address environmental issues in the city of Bamako, the capital of Mali, contained examples of both generic and specific adaptive strategies. In 1999, flash floods caused death and destruction throughout Bamako. At the same time, socio-environmental problems plagued the population, including non-existent wastewater collection and treatment, inadequate solid waste management, unhygienic individual behaviour, and poor urban management. Problems were particularly severe in the informal peri-urban settlements inhabited by 45 percent of the inhabitants (Setchell, 2008). A four year programme to improve stormwater management was undertaken in one of the most flood-affected areas of the city including: restoration of channel capacity through the removal of several hundred tons of accumulated refuse and debris, which improved drainage capacity and reduced flood risk; improving water retention capacity by constructing slip trenches (soak pits), reducing runoff volume and impacts; and establishing a refuse collection and disposal service. For the first time in the city, the programme planning involved stakeholder participation in combination with a comprehensive planning framework. The capacity of non-governmental organizations (NGOs), community-based organizations (CBOs) and informal sector groups involved in the process was strengthened so that they would be able to: prepare terms of reference; undertake further studies; and conduct public information campaigns (UN habitat, 2010a, UN Habitat). Implementation of this programme also involved setting up of partnerships between local profit-seeking bodies called Groupement d'Intérêt Economique (GIEs) and the communes of Bamako, which have institutional responsibility for waste collection. Furthermore, links were made with individual households and local farmers who use up to 60% of the collected waste. Local employment opportunities were created related to drainage and retention improvements, refuse collection and disposal, and the initiation of a composting operation (UN habitat, 2010a).

This case study illustrates that tackling flooding and environmental threats while supporting local institutions and stakeholders and promoting good governance, can significantly contribute to an improvement of a city's adaptive capacity, making communities resilient to future challenges in flooding, while addressing urban management needs (UN Habitat).

4. Implementing the principles

Through an iterative comparative approach in preparation of ‘*Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century*’ and during the numerous local and international workshops led to the distillation of twelve key principles for policy and practice in integrated urban flood risk management. These are listed below in table 1.

Table 1: Twelve key principles for integrated urban flood risk management (source (Jha et al., 2012))

1.	There is no flood management blueprint.
2.	Designs for flood management must be able to cope with a changing and uncertain future.
3.	Rapid urbanization requires the integration of flood risk management into regular urban planning and governance.
4.	An integrated strategy requires the use of both structural and non-structural measures and good metrics for “getting the balance right”.
5.	Heavily engineered structural measures can transfer risk upstream and downstream.
6.	It is impossible to entirely eliminate the risk from flooding.
7.	Many flood management measures have co-benefits over and above their flood management role.
8.	It is important to consider the wider social and ecological consequences of flood management spending.
9.	Clarity of responsibility for constructing and running flood risk programs is critical.
10.	Implementing flood risk management measures requires multi-stakeholder cooperation.
11.	Continuous communication to raise awareness and reinforce preparedness is necessary.
12.	Plan to recover quickly after flooding and use the recovery to build capacity.

Integrated urban flood risk management is an iterative five step process starting with understanding the hazard, through to identifying measures, planning, implementing and evaluating the results. It is recognized that measures will reduce but never eliminate risk. Similarly, the maximum potential reduction may not be provided in the short-term due to practical and resource considerations. Risk reduction should be a long-term target to be approached through a series of cycles. The principles must be borne in mind at each step in the process and in each iteration. By combining the principles with the planning framework it is possible to derive a checklist for benchmarking the flood risk management process as shown in table 2.

Table 2: Benchmarking the flood planning cycle (after (Jha et al., 2012))

1. Understand	<ul style="list-style-type: none"> Multiple sources of hazard and risk and extreme events. Potential future changes due to climate change and urbanisation. Diversity of flood management roles and urban form. Capability and limitations of approaches. The wider catchment. Wider urban management and hazard context. Vulnerability and resilience in its broadest sense. Governance structures surrounding communities at risk. The local assessment of need using participatory approaches. How to share information in the most accessible way.
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	The residual risk and future need for resources for recovery.
2. Identify	<p>Approaches to tackle each source of flood hazard.</p> <p>Approaches which are robust to future changes.</p> <p>Synergies with existing roles.</p> <p>Structural and non structural measures for full consideration.</p> <p>Whether risk is transferred and to where.</p> <p>What will happen if measures are overtopped or fail?</p> <p>Synergies with other urban management goals.</p> <p>Environmental and social impacts of proposed measures.</p> <p>Capabilities of local networks, experts, businesses, NGOs and other stakeholders.</p> <p>Costs, benefits and consequences.</p> <p>Ways of dealing with residual risk such as financing for speedy recovery.</p>
3. Plan	<p>Re-examine existing structures, measures and plans.</p> <p>Identify under what circumstances plans would need reviewing.</p> <p>Consult widely and engage in cross departmental planning.</p> <p>Plan for the long term including maintenance, forecasting and warning systems.</p> <p>Plan to set up compensation schemes, consult widely.</p> <p>Plan to fail gracefully when design levels are exceeded.</p> <p>Consult widely and engage in joint planning with other stakeholders.</p> <p>Use metrics such as Multi-criteria analysis to make the process inclusive.</p> <p>Engage all stakeholders but clearly define their remits.</p> <p>Put in place agreements for support and mutual cooperation.</p> <p>Share and consult on detailed plans.</p> <p>Plan emergency procedures, put disaster management infrastructure in safe zones.</p>
4. Implement	<p>Tailor implementation to local customs and preference.</p> <p>Build in flexibility.</p> <p>Coordinate the implementation to fit in with other urban cycles.</p> <p>Prioritise the most cost effective measures, often nonstructural.</p> <p>Communicate changes in risk.</p> <p>Set up warning and evacuation systems to offset residual risk.</p> <p>Consider co-financing opportunities and involve all stakeholders.</p> <p>Involve stakeholders in evaluation and put in place grievance procedures.</p> <p>Assign responsibilities using legislation or redefinition of departmental roles if necessary.</p> <p>Involve the maximum number of stakeholders in the implementation.</p> <p>Conduct awareness campaigns around new roles and the limits of implemented measures.</p> <p>Prioritise critical infrastructure and the vulnerable and build back better.</p>
5. Evaluate	<p>Recognise relative risk reduction.</p> <p>Test robustness to future scenarios.</p> <p>Monitor agreed targets.</p> <p>Identify routes to failure.</p> <p>Monitor awareness of changing risk.</p> <p>Measure and report performance against planned protection levels.</p> <p>Identify flood benefits and wider benefits separately if possible.</p> <p>Use participatory approaches to evaluate social and environmental impacts.</p> <p>Get feedback from stakeholders who were involved in the planning stages.</p> <p>Ensure stakeholders goals are addressed in the evaluation.</p> <p>Communicate the results of evaluations including the successful avoidance of damage.</p> <p>Check whether recovery after events has increased the resilience to future events.</p>

Source: After (Jha et al., 2012).

Each step relies on community and stakeholder consultations, and where possible, should adopt local solutions which fit communities' needs. These steps bring the concepts of resilience, consultation and the importance of local needs and capacity assessment to the attention of flood risk management planners. The use of an iterative cycle maximises adaptability to changing circumstances.

5. Summary and Conclusions

Flooding is a serious threat to the safety and economic wellbeing of populations of many cities worldwide. The threat from flooding is growing with increased urbanisation, rapid growth and densification of metropolitan areas in and around our major cities and changing climates also contribute to a future that may see more flooding from multiple sources with greater unpredictability. Action to tackle flood risk is urgently needed and many established measures can effectively reduce risk but action is often delayed or rejected. While it is not possible to completely eliminate flood risk, there is a need to develop approaches that are resilient to continued flood hazard and integrated into wider development plans.

Promoting an integrated flood risk management approach can be challenging as it involves approaches that may run counter to the natural desire to build and rely on structural (engineered) defences. While traditional methods have served reasonably well in the past, saving millions of lives, but they may not be flexible enough to adapt to an uncertain future of climate change and urbanisation trends. Modern flood risk management thinking emphasises the resilience of the built environment through a balanced approach of structural and non-structural measures, based on a wide participation of stakeholders and communities. Non-structural measures are inherently more flexible, and can prove extremely cost-effective. A balanced approach can support the adoption of robust measures with benefits under a wide range of future scenarios.

The application of the five step integrated planning and implementation cycle in the context of the twelve key principles outlined in *Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century* can assist policy makers to design integrated flood risk management programmes for cities that will lead to a more resilient future. They provide a framework for decision making that can lead to systematic implementation of alternative options while encourage participative approaches that will improve the stakeholder buy-in and enhance the sustainability of specific local solutions.

However, the existence of a guiding framework is just one step in building more resilient cities for the 21st century. The impetus to resource and engender change requires that the forward-looking flood risk management and adaptive resilience thinking remains high on the political and policy agenda. The role of risk management, urban development and city planners is critical in facing the flood risks.

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